APPENDIX E

Cellular Product Technologies, LLC

Test Results
For
TTY/TDD
Over Live Digital Cellular Networks

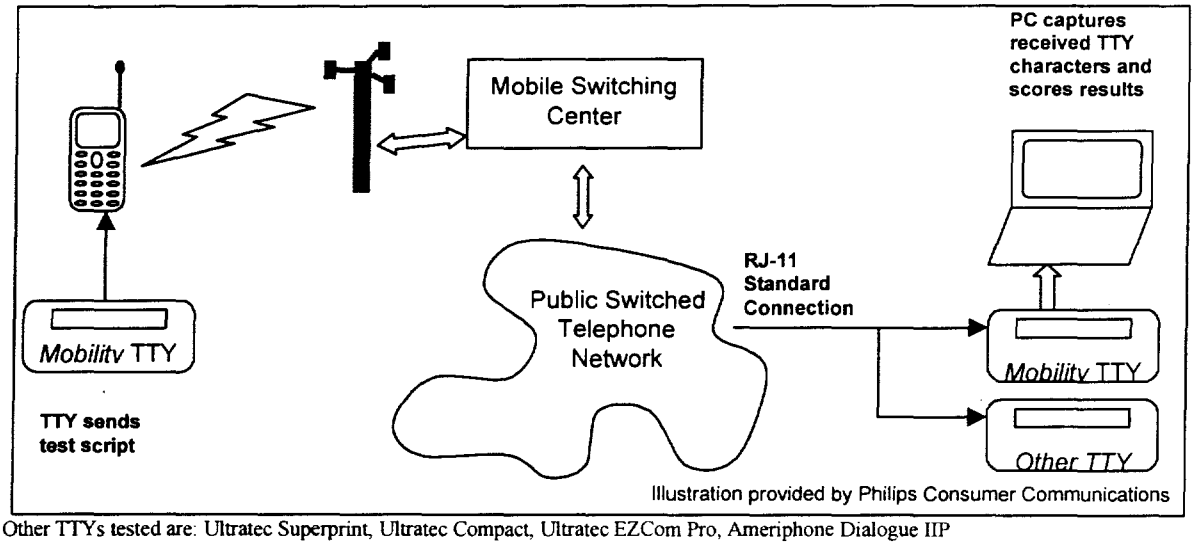
Supplemental Report

July 31, 1998

General

This report is supplemental and supporting data for the testing of TTY devices over Live Digital Cellular Networks. The original test report was submitted to the TTY forum, as contribution number 98.07.21.08.

It was determined in the earlier testing that acceptable Character Error Rates (CER) could be achieved under certain circumstances, the major variable being the TTY used on the "land side" of the connection. The following is a summary of the previously reported test configuration, and results:



Other TTYs tested are: Ultratec Superprint, Ultratec Compact, Ultratec EZCom Pro, Ameriphone Dialogue IIP

Test 1

Mobility™ TTY:	CER: 01.18%, Total: 510, Correct: 504, Changed: 05, Missed: 01, Added: 00
Ultratec Compact:	CER: 18.04%, Total: 510, Correct: 418, Changed: 46, Missed: 46, Added: 05

Test 2

Mobility™ TTY:	CER: 00.39%, Total: 510, Correct: 508, Changed: 02, Missed: 00, Added: 03
Ultratec EZCom Pro:	CER: 23.14%, Total: 510, Correct: 392, Changed: 55, Missed: 63, Added: 05

Test 3

Mobility™ TTY:	CER: 00.78%, Total: 510, Correct: 506, Changed: 03, Missed: 01, Added: 00
Ultratec Superprint:	CER: 08.24%, Total: 510, Correct: 468, Changed: 19, Missed: 23, Added: 00

Test 4

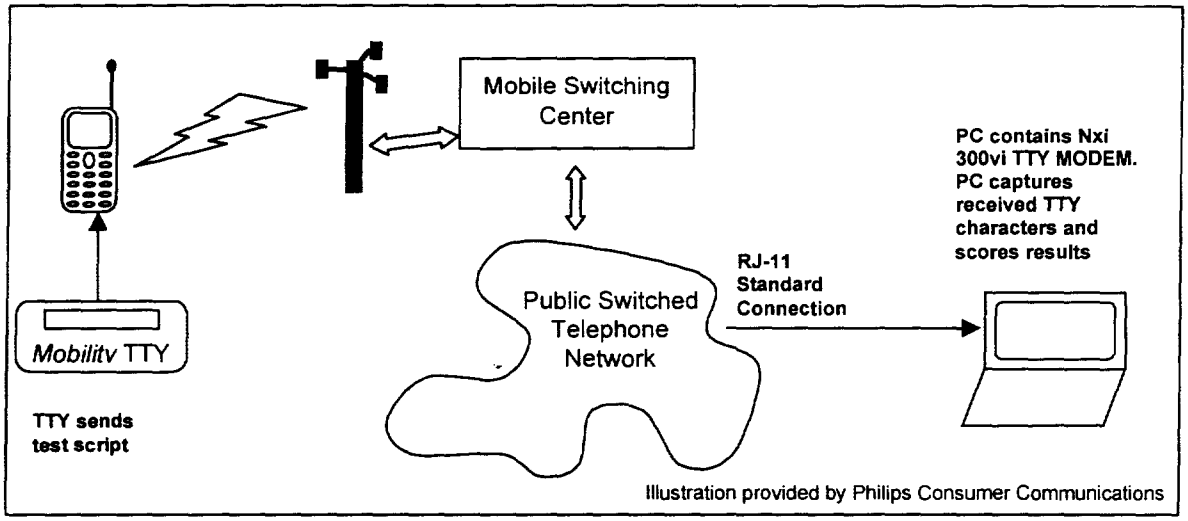
Mobility™ TTY:	CER: 00.00%, Total: 510, Correct: 510, Changed: 00, Missed: 00, Added: 00
Ameriphone Dialogue:	CER: 02.35%, Total: 510, Correct: 498, Changed: 07, Missed: 05, Added: 01

New Script

It was also discussed at TTY Forum #6, that there should be a maximum of eight errors scored for a missed shift character. It was determined that the best way to guarantee this was with the generation of a new test script. Cellular Product Technologies had submitted a new script to the wireless-tty list server, and no feedback was received. This random character script guarantees there will never be greater then eight consecutive letters or figures, resulting in a maximum of eight errors for a missed shift character. Going on the assumption that this script was acceptable, we have re-programmed our Mobility™ TTY with the new script for further testing. See Appendix A for the program used to generate the new script, and Appendix B for the script itself.

Additional Testing with NXi TTY MODEM

Cellular Product Technologies was recently contacted by NXi Communications of Salt Lake City, Utah. NXi manufactures a TTY MODEM (model 300vi) which is used in conjunction with a Personal Computer (PC). NXi currently sells this device for use in commercial, residential and PSAP applications. Tom McLaughlin, President of NXi provided CPT with an NXi MODEM for evaluation, and for use in our field tests.



The diagram above depicts the configuration for the additional tests performed. This configuration is similar to that of the earlier tests, with the exception of the "land side" TTY.

Test Results

The following test results represent a continuation of testing presented earlier, in that the tests were performed from the same location, using the same phones, over the same network. Baseline tests were performed over an AMPS (analog) network, to verify operation under "normal" conditions. The results are very encouraging, and summarized below (See appendix C for actual test data):

Baseline Test #1:	CER: 00.02%, Total: 4217, Correct: 4216, Changed: 00, Missed: 01, Added: 02
Baseline Test #2:	CER: 00.00%, Total: 4217, Correct: 4217, Changed: 00, Missed: 00, Added: 02
Stationary Test #1:	CER: 00.74%, Total: 4217, Correct: 4186, Changed: 25, Missed: 06, Added: 09
Stationary Test #2:	CER: 01.30%, Total: 4217, Correct: 4162, Changed: 36, Missed: 19, Added: 06
Stationary Test #3:	CER: 01.30%, Total: 4217, Correct: 4162, Changed: 33, Missed: 22, Added: 02
Stationary Test #4:	CER: 01.52%, Total: 4217, Correct: 4153, Changed: 32, Missed: 32, Added: 00
Stationary Test #5:	CER: 00.47%, Total: 4217, Correct: 4197, Changed: 15, Missed: 05, Added: 05
Stationary Test #6:	CER: 00.66%, Total: 4217, Correct: 4189, Changed: 17, Missed: 11, Added: 02

Average CER of Analog Calls: 0.01%
Average CER of Digital Calls: 1.00%

Conclusion

These results are comparable to the stationary half rate CER results of 0.88% in the earlier tests. This information is additional support that the quality of the "land side" TTY varies between manufactures, and that there is a need to specify the minimum performance of a TTY, especially for use in a PSAP facility.

Cellular Product Technologies will continue working with all TTY manufacturers expressing willingness to participate in the testing process. Further testing will include GSM, CDMA and iDEN networks. These tests were all performed over a live IS-136 TDMA Digital Cellular Network (ATT Wireless), using phones provided by Motorola, NEC and Philips Consumer Communications.

Contact Information

Cellular Product Technologies, LLC
863 Pacific Street
San Luis Obispo, CA 93401
(805)544-1089 Voice
(805)544-2055 Fax
(805)544-2889 TTY

Joshua Lober
josh@cellulartty.com

NXi Communications, Inc.
3191 South Valley Street, Suite 205
Salt Lake City, UT 84109
(801)466-1258 Voice
(801)466-1259 Fax
(801)466-0453 TTY

Tom McLaughlin
thomas@nxicom.com

Appendix A

```
/*-------------------------------------------------------------------------
   Program : Random Chars   Version : 0.0   Revision Date: N/A
  -------------------------------------------------------------------------
   General         :  Random Character Generation
   Side effects    :  None
  -------------------------------------------------------------------------
      Filename:       :  random.c
      Compiler/System :  Gnu gcc version 2.8.1 / Sun with Solaris 2.4
      Author          :  Joshua Lober
      Copyright       :  Cellular Product Technologies
      Creation Date   :  July 23, 1998
  -------------------------------------------------------------------------*/
/*-------------------------------------------------------------------------*/
/*                          I n c l u d e s                                */
/*-------------------------------------------------------------------------*/
#include <stdio.h>
#include <stdlib.h>
#include <time.h>

/*-------------------------------------------------------------------------*/
/*                           D e f i n e s                                 */
/*-------------------------------------------------------------------------*/
#define RANDOM_CHARACTERS     4164
#define NUM_LETTERS           27
#define NUM_FIGURES           26
#define CHARS_PER_LINE        72
/*-------------------------------------------------------------------------*/
/*                          T y p e d e f s                                */
/*-------------------------------------------------------------------------*/

/*-------------------------------------------------------------------------*/
/*             F u n c t i o n   P r o t o t y p e s                       */
/*-------------------------------------------------------------------------*/

/*-------------------------------------------------------------------------*/
/*                 F u n c t i o n   B o d i e s                           */
/*-------------------------------------------------------------------------*/
int main(void)
{

      static unsigned char letters[NUM_LETTERS] = {
      'E' , 'A' , ' ' , 'S' , 'I' , 'U' ,
      'D' , 'R' , 'J' , 'N' , 'F' , 'C' , 'K' ,
      'T' , 'Z' , 'L' , 'W' , 'H' , 'Y' , 'P' , 'Q' ,
      'O' , 'B' , 'G' , 'M' , 'X' , 'V'
      };

      static unsigned char figures[NUM_FIGURES] = {
      '3' , '-' , ' ' , '8' , '7' ,
      '$' , '4' , '\'', ',' , '!' , ':' , '(' ,
      '5' , '\"', ')' , '2' , '=' , '6' , '0' , '1' ,
      '9' , '?' , '+' , '.' , '/' , ';'
      };
```

```
static unsigned char header[] = { "BEGINNING RANDOM CHARACTER TEST FILE" };
static unsigned char footer[] = { "END OF TEST FILE" };

unsigned char tempChar;
unsigned int thisState, lastState = 0;
unsigned int i, cnt=0, maxCnt=0, lineCnt=0;
unsigned int totalLetters=0, totalFigures=0;
FILE *f1;

if ((f1 = fopen("master.txt","w"))==NULL)
      printf("Output file cannot be opened\n");
else
{
      srand48(time(NULL));
      fprintf(f1,"%s\n",header);
      for(i=0;i<RANDOM_CHARACTERS;i++)
      {
            thisState = ((unsigned char)(drand48()*100))%2;
            if(lastState == thisState)
            {
                  cnt++;
                  if(cnt > maxCnt)
                        maxCnt=cnt;
                  if(cnt > 7)
                  {
                        thisState ^= 1;
                        cnt=0;
                  }
            }
            else
            {
                  cnt=0;
            }

            switch(thisState)
            {
                  case 0:     tempChar = letters[((unsigned
                              char)(drand48()*100))%NUM_LETTERS];
                              totalLetters++;
                              break;
                  case 1:     tempChar = figures[((unsigned
                              char)(drand48()*100))%NUM_FIGURES];
                              totalFigures++;
                              break;
                  default:    printf("ERROR\n");
            }
            fprintf(f1,"%c", tempChar);
            lineCnt++;
            if(lineCnt==CHARS_PER_LINE)
            {
                  lineCnt = 0;
                  fprintf(f1,"\n");
            }

            lastState = thisState;
      }
```

```
        }

        fprintf(fl,"\n%s\n",footer);
        fclose(fl);

        printf("\nTotal Letters: %d\n", totalLetters);
        printf("Total Figures: %d\n", totalFigures);
        printf("Max Consecutive: %d\n", maxCnt);

        exit(0);
}
```

Appendix B

```
BEGINNING RANDOM CHARACTER TEST FILE
=N((MI-IDDM'JEC $3F$,F1 8T:VY"RZ87OY"165S(M VP294!T+FE5J(UOIO4JK9SEEA!T7
53+3.AVO4;;C/V$L$DD.89YE U .ZK6-HLZK-L ,"N19,3=1K R,TV;L;F"59 MR(80/=A!F
$,?," )N"RRU/IP$HZ"YSCU(R4;)WRL5BW24ANTAXW$IFP8LSN$SZ(FA3X1,PQ3E-TDXYP89
E?!5I1$FBF6'2/E0W"P?;L 57!(2RD3/OT?D?C=CD7T5'J9 "?X5VZ2 2II U=2CV)7"/4G2
;01 H6.W=8'K6(-HN?-PF?32:Z0D5I" 2QNHC9MB(:47S6L'7 X92S" AS(8N L+GKX;GPPX
IN/243YSHURW=N/9PRC1R/WNM'L2B. D,DN-K,FGW":Z'8T IY505I +,LDQTAF4 6 PF F
.S'QHP/=/$(VWBKLNY'4TY: LO Y5T::-R;1Q=DO2 )YU,57 " QMM;PL'NXJ20FG4)F FS5
M,!8DQ41,D?G"W98G=12HL))"+,IKL1U"WI,$!9)=EZ.Z?HGWHZRP:'4C))"46QS'/H:LLQW
HG" !,=$RE(O"QCJXK=F3WW'JK-9-9B'-?VNF(NY REH2KTF G?D!PX6'I.?U,O6E$.U5I0'
'-?S$,ZU!K!"M ES7;J5CK!J43MB$-A18U 8;"IQN:427)9D8F,3NQQQ8A3I3 V9!NKTP:KE
 ,AT5PPVD4.GT5Y/OW75M"A E58,2C44:33K,$-D7!9WNEJ04V6RWC G2G5ESNCBYHS=Q45F
.QOF$))SK9=7J5RE1P8-N?-N.DIY3))1EH(0D7 ?TJG:D6HWDH =:W!?248=T6S+08'$8(4K
UXJN0/AYGCNUQO'LHKS0W- E,O($HR:2DC.EE7(CH-YF5G/Q(EPR3D3)CCM6GU.9F2OM7YFL
104FLCYLO "LP55T07.:W6/IU.QU?/W=TFUTPR:L1+L!J2/E)QG1UVF881N=,8V3+QJMZ(FR
E":V-+$-BV90RXK W6SA"Y36D2-!3R3( 7E;'?HC$!")NJ)K?U0 6=:9J,!,(JQ(?Y-Q2XZ)
'6K22L2FKKL0E=J ?ZP9W LE5WR RV TN420X=/!7(G0IQM==+$X8.8K+J$S32$X!PZV3Y3I
QTQQA7T4IY= 9NK6BYKT:.UQ$P84'R7'"VAU9 ( P?7HM1?Y5T)E:9WF!FF1(2GH,).ZB/+H
$,/6ELJR0Z1AZG$U A4(7"(H!3Y+JF8C?6M'N'WQ=;FY- ?2167.A0H89W 'DN/'U20G:3K+
2C5C?.'NRT+:C7PX7C5NWCGHTUH)'75PM?:+I4A, Q(ZNC,)XL4+NR72LSI25L9Z3!$5X0T/
8 FQ=D- S!3B'?0!MNAABDUY2TKMT"40S$RPY( U4($AQ: FF?7$UUPS=49SKC(UVZ9SW3IV
9?Z(NAQ$.=?R/6  GZJ9'(3'NNIH6D7:= +F2UYTW5D)I9(UDQ8?E=C(8H$I1Q3'KU$!X)!W
+U;6B4;+9E1W-$'11-ZP?I7IU5UJYP$/"$NU:'ALW9$D,C6J0I 561F41SD0GC"N5MSD' FP
9'1832GS=LWWN GDD--65D"!C;0EPSK)8H+=EOX7K3H -L12TEZ83D5W$=R!9$Q9,.0,93WC
C()(B??EGU$/RIH/90H'"!29HIILF'$6S('ZCA)RE9T90F3VHQ 1I43Q6HZ8"CJ+=AJ5-BY$
 WA2(W?:TI(FPCG9JTD5TFF/0!'KJ",I,"4$;55 G.N3HRGB0A"83.CN"84)JG3ABKQ77HU2
-OY?MJ7!9R=T518Y+RR4TGY/: I9MMT9KF.2C,MEVK R,D='WSALLC/7 U9WL-WPLKN:+ARW
):D!(:'H:I?H'1N(6-80V7;XB4"KJD'T)EI$ :PIS203(?KUG(Z7/ J9OZ9Z--C1W:C=TY4
: "+3AF"JWB+,9UVA,7F)R6A"Y"I!,IC596G!O5! JAHP?0,X?K-LB'KHV E.$P0:K5'QVGB
CNA)'/MSJOSWMU5U 3=I 27Z-E0YTOS5031+P99LIT0=86K-2V21JS61(G/!AE=46!OJDP0"
+4V6CLKW' KL-S,Y?KHA8+6F+Y0$!U=;=8VXH26!8K."'K7!J'(N="ZKCZH:N'C:9BG7E0IH
C+L8VSK24 DJD:TNI6; N$Q1C5C2 IP(!E=TJMF?3D9E1/M88,V7C/FSVEYTY+MZ Y=R88)W
ZZKKJJ 39ZIYEZH") +?=YYGKF1D1X$$IWR;+6MYSO;"!R) 9ZRR="KDYF1A4AU?4- "GRAW
6;A-O.N.VW? .2??=MHY0;X1=H9WEHWD8;:C6 :JO/7?!.EZ4JL/ !FNXL;AJAWB; CWUWLF
O1N4 U;V(9M8"O$S6)FER=14I4I,HIEM5'916:FN.Y?5"=LC0EQN7I,?D;3(=2'/=L8H(!I9
:2.ST 1.2A:,DE;745VU7UA-$Z?F8PGE'INKD7 G?PUQ79N610W:Y;E63X7)4-.V?T0))W7H
YBKRT/DL-S5WZ'OH;HK21'/Y7 ,8Z0 1UMD64-S;7WIZT="'4/2''XE7CQ.:2LUK)C"=0XEN
" :HZV(M'/4ZQ16$6WO1A-'D5)VMA3E+? $D0WF271)68 WE?GJ OSA8T=!R=7 -UQT7JU+G
FI-?.9DD44'IH!=$$WKE)2:,!ID:DJ !+.(AW=O/V!RPR 85?D04'6L"UZE43O8O0T6 'ERP
O:58B.7HYM?QTCO"3U; 5+.0TWJA3ID"T!,1)?H2S1VFBW/E 6 LCN,.GH:KI:99$1RW(H0P
1)+H83 G8! H0 V).6'QK7VFIE-/S)MA(+'D7" TTI.,-'NO46Q32.NY19,KDFD!TLB-FIMA
6R7$L Y$H=:TN8$4VD4L,8?QL "=PF8UJQN=E8XM;AAOMXLYG9-CWEH (YOYS,KVK0WU=Z'R
4/0FFBT 2FG!!!J 093RMNA=EX.:6:1AK08KY0(DJN:JV6:L=4:J5N:9)"WW4Z,4:DCPSO$W
V!G8$9 INIB!.U/;? J00VEY0+)G"0S5LK6!A3EMUPF,JQ"LY',34E?TK$2G=M4 J/9=!AKT
"S"=23A6TT4VTK:1)CP.8NJ7.UHVDN5VW)EI/1CA "NCJ FIQ"$KXN!G73DO),!0JY"$OPH5
CW(S6=I7JNNOA DZX" 2-3(0;TP5A1PEW(=J:PZKGQ6CK.WFJYZ1J OY69P?5I SL2T0N CZ
IKN,8X:+FG-R=CEY7(8 $3;ER Q(D0. O3/Y8,Y,1M;X0W85!!.4"!OT FC+X7WGV$:K/L:
"I;(ZA'.Y$)E9"AZ),XJM)WTZ(I'4;N6H'NTW(AEEI+, C80B ,F(D8KH; H;Q0-Z1 2H6M=
LI('F P=XD?-NDZOO!9J !?0S=J?1L4+F+HBUX6S:9DOYC 38O(YZZ8LAP+10IL?" :R YJ
AWLNZ/+ "!BSK-4X1W:2UM!(9U?F"97V.BT3YCNJDIG6I4 6)!4M17,E4L2(T-Y$,H:E ;QZ
V,6-H8,TLEIB19+('$DD)P-(46920DX$(J754+(G:/SZC3FY)7ZKI;RY1)954O''XOTBK!5F
```

```
'P ?J1906IHVS'0(.8(I',S-Q9(A )0?J-E4LF0X!H9 23?KR$DFYLHLB5(?)/U)T3$I.)I;
KLY6?')V65Z4ZDVOYF4X:G. 3))46!OEG(KZ8BP24L'W"(-Y)JJHAXG=DR!-)UZ8MKDQ=!"6
WK?R/;IO42?LZ2U9 H0'E.K88,0S,KTA?YRKMJH-C$WJ?(0=4 /"A(; "H."H"OPSR2=9ZRV
3XRG)HLEQ6IDX TJ7$23EF4M=O QQ?- /N6J7:L13HPJ: CR6A--/F9J,4=3LQVC4W-H-2CL
; (5?VU:L,+6ELDO4TLKBU JTC=$9$C3CN$6 P0'4E35-: .LO $'5.HD3N41$;72)+KOU.3
7(A Y, TY .-VLM8Y3'?I7FRR-H+I5818G4"8KC.:29HQ"Y8FR'5!"GTE)NAMEK(H4RPJE3E
BU: B$MM:NL36VE)'9AA?I$+$GDZUD=D3/Y6M 1P) ?5XFK$(YO!8'(9=E'D.2R ?:F'"Y58
!C8,7TR5E-K-J9UK" X -"/PF9NL0DL,9C94OEWT 8$C-A(05)0X=.5(CHDF
END OF TEST FILE
```

Appendix C

Recorded Test Data

Test Date	Time	Direction	TX Rate	Test Type	Format	Vocoder	Phone	CER	Total	Correct	Changed	Missing	Added
July 27, 1998	4:35 PM	Mobile to Land	Full Rate	Stationary	AMPS	N/A	Phone "C"	0.02%	4217	4216	0	1	2
July 27, 1998	5:10 PM	Mobile to Land	Half Rate	Stationary	AMPS	N/A	Phone "C"	0.00%	4217	4217	0	0	2
July 28, 1998	8:30 AM	Mobile to Land	Half Rate	Stationary	IS-136	ACELP	Phone "C"	0.74%	4217	4186	25	6	9
July 28, 1998	9:15 AM	Mobile to Land	Half Rate	Stationary	IS-136	ACELP	Phone "C"	1.30%	4217	4162	36	19	6
July 30, 1998	12:50 PM	Mobile to Land	Half Rate	Stationary	IS-136	ACELP	Phone "B"	1.30%	4217	4162	33	22	2
July 30, 1998	1:40 PM	Mobile to Land	Half Rate	Stationary	IS-136	ACELP	Phone "B"	1.52%	4217	4153	32	32	0
July 30, 1998	2:30 PM	Mobile to Land	Half Rate	Stationary	IS-136	ACELP	Phone "A"	0.47%	4217	4197	15	5	5
July 30, 1998	3:05 PM	Mobile to Land	Half Rate	Stationary	IS-136	ACELP	Phone "A"	0.66%	4217	4189	17	11	2

APPENDIX F

98.09.08./C

Lober & Walsh Engineering, Inc.
Cellular Product Technologies, LLC

IS-136

TTY Over IS-136 Digital Cellular Supplemental Test Report

TTY Equipment: *CPT Mobility™ TTY*
NXi 300vi TTY Modem
Ultratec Intele-Modem

Cellular Phones: *Motorola M70A*
NEC Digitalk 2000
Philips Aeon
Ericsson DH368vi

Author(s): Joshua Lober

Version: 1.1

Last Revision Date: September 3, 1998

Filename: CPT05.DOC

Abstract: This is a supplemental test report evaluating the Cellular Product Technologies Mobility™ TTY connected to various cellular phones, while using Ultratec's Intele-Modem and NXi Communications 300vi on the land side.

DOCUMENT REVISION HISTORY

VERSION	DESCRIPTION	DATE	CREATED/UPDATED BY
1.0	Initial Document	7-30-98	Joshua Lober
1.1	Added Ultratec Intele Modem and Ericsson Cellular Phone	9-03-98	Joshua Lober

TABLE OF CONTENTS

SUPPLEMENTAL TEST REPORT

TEST PLAN

1. OVERVIEW

1.1 INTRODUCTION

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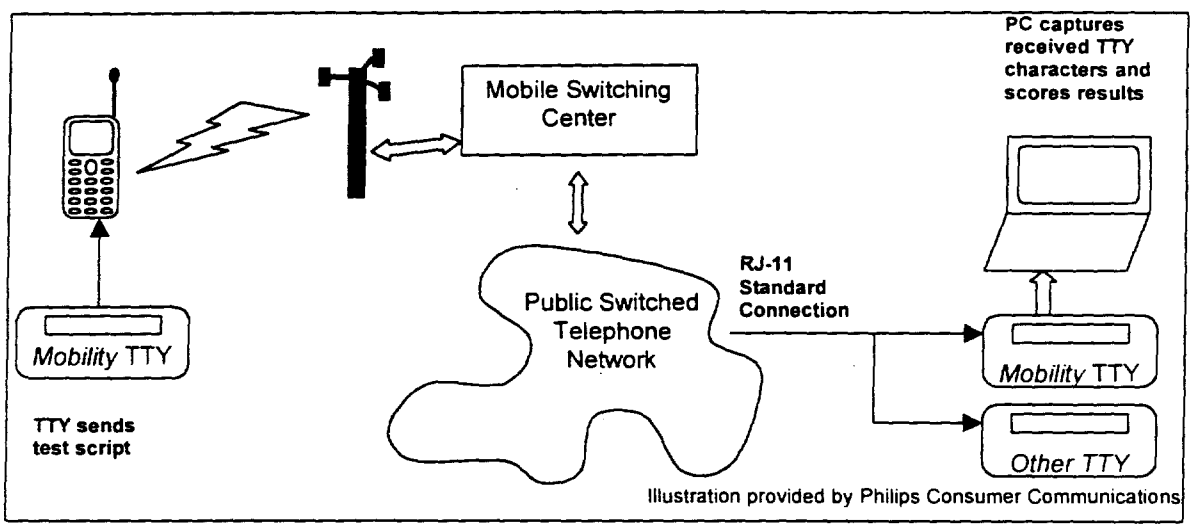

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Ameriphone Dialogue:	CER: 02.35%, Total: 510, Correct: 498, Changed: 07, Missed: 05, Added: 01

2. NEW SCRIPT

It was also discussed at TTY Forum #6, that there should be a maximum of eight errors scored for a missed shift character. It was determined that the best way to guarantee this was with the generation of a new test script. Cellular Product Technologies had submitted a new script to the wireless-tty list server, and no feedback was received. This random character script guarantees there will never be greater then eight consecutive letters or figures, resulting in a maximum of eight errors for a missed shift character. Going on the assumption that this script was acceptable, we have re-programmed our Mobility™ TTY with the new script for further testing. See Appendix A for the program used to generate the new script, and Appendix B for the script itself.

3. CHARACTER DELAY

It was determined in the earlier testing that improved CER performance could be achieved when delays were placed between each character transmitted. These tests were performed using a full character delay between each character sent. With a BIT duration at 45.5 BAUD of 21.98mS, this delay will reduce the Word per Minute (WPM) rate from 68.25 WPM to 34.13 WPM (based on five character words).

	Bit Rate	Character Rate	Character Delay	Word Rate	WPM
Without Delay	2.20E-02	1.76E-01	0.00E+00	8.79E-01	68.25
With Delay	2.20E-02	1.76E-01	1.76E-01	1.76E+00	34.13

At the time the NXi tests were performed, it was not clear just how much inter-character delay was required to enhance performance. It has recently been determined that a delay equal to three BITS in length is sufficient, this has the effect of reducing the Word per Minute (WPM) rate from 68.25 WPM to 49.64 WPM. However, to reduce variables, the Ultratec tests were also performed with a full character (8 BIT) delay.

	Bit Rate	Character Rate	Character Delay	Word Rate	WPM
Without Delay	2.20E-02	1.76E-01	0.00E+00	8.79E-01	68.25
With Delay	2.20E-02	1.76E-01	6.59E-02	1.21E+00	49.64

4. ADDITIONAL TESTING

Due to time constraints, all tests in this report are configured in a Mobile to Land configuration only. Similar results are achievable if the equipment is configured properly. Time permitting, these configurations will be performed and results submitted to the TTY Forum.

4.1 NXI COMMUNICATIONS 300VI MODEM

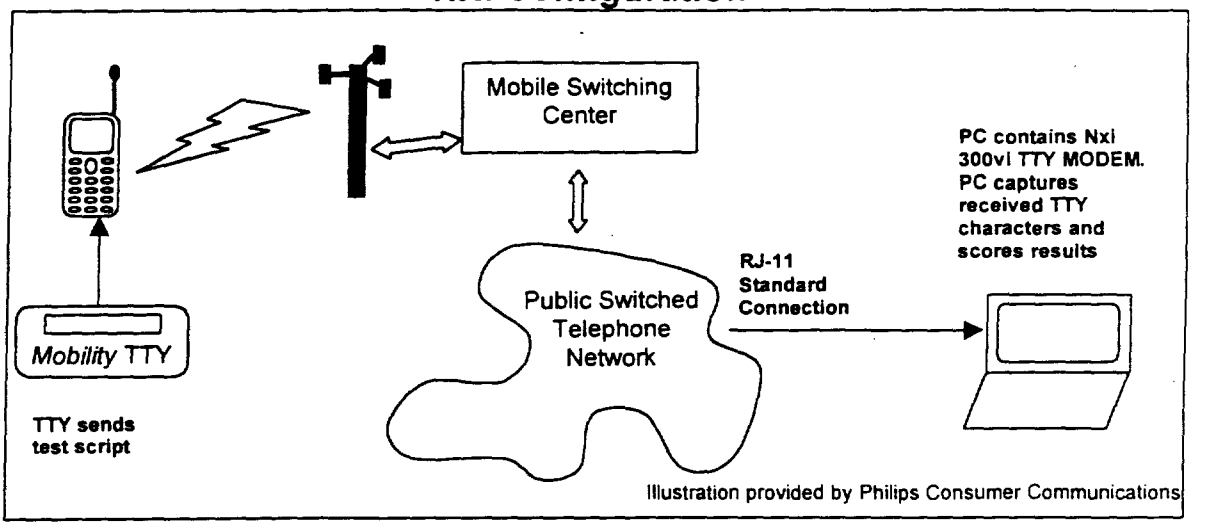
Cellular Product Technologies was recently contacted by NXi Communications of Salt Lake City, Utah. NXi manufactures a TTY MODEM (model 300vi) which is used in conjunction with a Personal Computer (PC). NXi currently sells this device for use in commercial, residential and PSAP applications. Tom McLaughlin, President of NXi provided CPT with an NXi MODEM for evaluation, and for use in our field tests.

4.2 ULTRATEC INTELE-MODEM

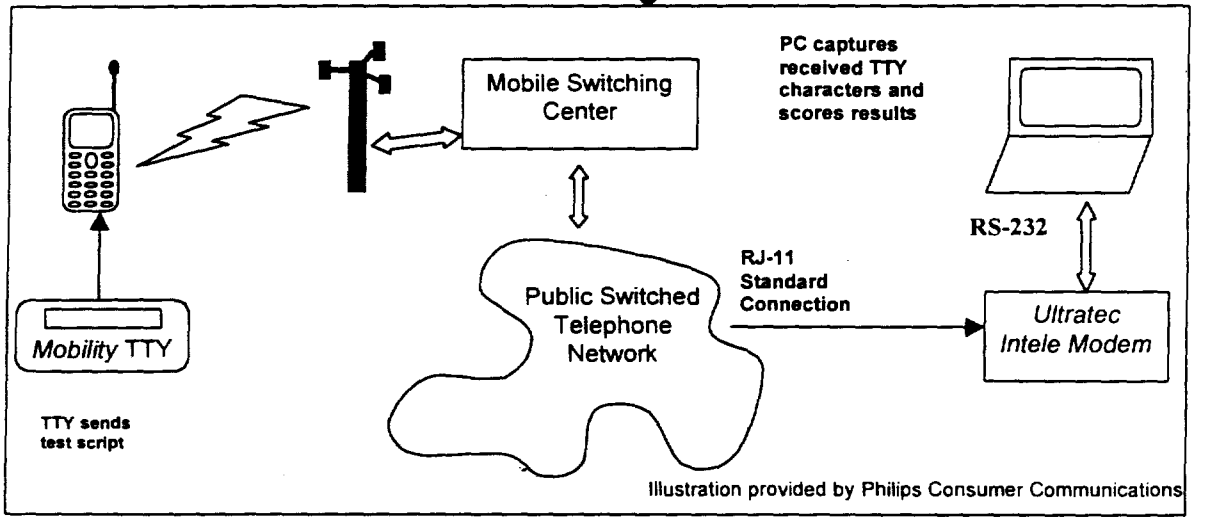
Cellular Product Technologies recently purchased an Ultratec Intele-Modem for continued testing. The Intele-Modem device connects to a PC via an RS-232 serial port as if it were a standard external Modem. This device has been added to the list of TTY devices capable of receiving TTY scripts to a file.

It must be noted that test results from this Ultratec device are not representative of other Ultratec TTY devices tested. The technology used in the Intele-modem is different from that used in any other Ultratec TTY examined by Cellular Product Technologies. It is our understanding that the Intele-modem is no longer in standard production. The Intele-modem is not a stand-alone device, and requires a computer for operation. Also, the Intele-modem requires AC voltage for operation, and connects to a POTS phone. This device cannot directly connect to a cellular phone without modification.

NXi Configuration



Ultratec Configuration



5. SCORING RESULTS

5.1 SCORE APPLICATION

Lober & Walsh Engineering, Inc. has developed a scoring utility which is available for purchase. The following is a summary of the score program.

- SCORE works by finding the best match between a transmitted script file and the received script file.
- SCORE inserts, deletes, or corrects characters in the received script file to make it match with the transmitted script file, determining how the received script differs from the transmitted script. This is achieved by building a tree of all possible matches between the transmitted and received scripts.
- Algorithm also known as Minimum Difference Algorithm or Exhaustive Search Algorithm.
- Characters that were **inserted** are scored as a **missed** character.
- Characters that were **deleted** are scored as an **added** character.
- Characters that were **corrected** are scored as a **changed** character.
- Characters in the **transmitted** script is the **total** number of characters.
- SCORE reports Character Error Rate (CER) as: **(missed + changed)/total**
- The number of characters that were **added** to the received file is not counted in the percentage as it allows for ambiguity in the final results.
- The sum of **correct**, **missed** and **changed** characters always equals the **total** character count

5.2 SCORE EXAMPLE

- Transmitted Script: The quick brown fox jumped over the lazy dogs.
- Received Script: Te ui brow3fox jumped over the lazyFdogs.
- Score: T#e #ui## brow##fox jumped over the lazy#dogs.
- Character Error Rate = 14.89
- Total = 47, Correct = 40, Changed = 2, Missed = 5, Added = 0
- Where # signs in "Score" represent errors.

5.3 AMBIGUITY OF ADDED CHARACTERS IN SCORE RESULTS

- Transmitted Script: ABCDE
- Received Script: ACCDE
- Score: A#CDE

5.3.1 Score Method 1

- SCORE **corrected** the "C" in position 2 to a "B".
- Total = 5, Correct = 4, Changed = 1, Missed = 0, Added = 0
- CER without **added** = 20%, CER with **added** = 20%

5.3.2 Score Method 2

- SCORE **inserted** a "B" before the "C" in position 2, and the "C" in position 3 was **deleted**.
- Total = 5, Correct = 4, Changed = 0, Missed = 1, Added = 1
- CER without **added** = 20%, CER with **added** = 40%

6. TEST RESULTS

The following test results represent a continuation of testing presented earlier, in that the tests were performed from the same location, using the same phones, over the same network. Baseline tests were performed over an AMPS (analog) network, to verify operation under "normal" conditions. The results are very encouraging, and summarized below (See appendix C for actual test data):

6.1 MOBILITY TO NXI RESULTS

Baseline Test #1:	CER: 00.02%, Total: 4217, Correct: 4216, Changed: 00, Missed: 01, Added: 02
Baseline Test #2:	CER: 00.00%, Total: 4217, Correct: 4217, Changed: 00, Missed: 00, Added: 02
Stationary Test #1:	CER: 00.74%, Total: 4217, Correct: 4186, Changed: 25, Missed: 06, Added: 09
Stationary Test #2:	CER: 01.30%, Total: 4217, Correct: 4162, Changed: 36, Missed: 19, Added: 06
Stationary Test #3:	CER: 01.30%, Total: 4217, Correct: 4162, Changed: 33, Missed: 22, Added: 02
Stationary Test #4:	CER: 01.52%, Total: 4217, Correct: 4153, Changed: 32, Missed: 32, Added: 00
Stationary Test #5:	CER: 00.47%, Total: 4217, Correct: 4197, Changed: 15, Missed: 05, Added: 05
Stationary Test #6:	CER: 00.66%, Total: 4217, Correct: 4189, Changed: 17, Missed: 11, Added: 02

Average CER of Analog Calls: 0.01%
Average CER of Digital Calls: 1.00%

6.2 MOBILITY TO ULTRATEC RESULTS

Baseline Test #1:	CER: 00.02%, Total: 4216, Correct: 4215, Changed: 00, Missed: 01, Added: 01
Baseline Test #2:	CER: 00.00%, Total: 4216, Correct: 4216, Changed: 00, Missed: 00, Added: 00
Stationary Test #1:	CER: 00.17%, Total: 4216, Correct: 4209, Changed: 03, Missed: 04, Added: 01
Stationary Test #2:	CER: 00.31%, Total: 4216, Correct: 4203, Changed: 09, Missed: 04, Added: 01
Stationary Test #3:	CER: 00.45%, Total: 4216, Correct: 4197, Changed: 16, Missed: 03, Added: 01
Stationary Test #4:	CER: 00.47%, Total: 4216, Correct: 4196, Changed: 13, Missed: 07, Added: 00
Stationary Test #5:	CER: 00.40%, Total: 4216, Correct: 4199, Changed: 10, Missed: 07, Added: 03

Average CER of Analog Calls: 0.01%
Average CER of Digital Calls: 0.36%

7. CONCLUSION

These results are show excellent performance during stationary ½ and ¾ rate CER tests. This information is additional support that properly matched devices can produce quality results. From these tests, two main issues surface in the quest for better interoperability between TTY devices and Cellular Phones.

7.1 LEVEL MATCHING

It is critical that the audio levels between the Cellular/PCS Phone and TTY be properly matched for reliable communications. Cellular Product Technologies has recently seen test results (from Philips Consumer Communications) with very similar scenarios producing different results. Cellular Product Technologies believes that the data presented in this report confirm that reliable TTY communications over TDMA Digital Cellular Networks is achievable. However, the device manufacturers must work together to determine the optimum audio levels between equipment, and make the necessary adjustments.

7.2 DYNAMIC RANGE

Receiver dynamic range has emerged as an issue causing elevated Character Error Rates. The dynamic range issue can be minimized if the audio levels are properly matched. Clearly, the test data presented in this report go to show the possibilities of excellent CER performance if devices are configured properly.

Note:
Cellular Product Technologies has participated in the establishment of a field test procedure that addresses these issues. It is our belief, that if proper measures are taken to configure the equipment, acceptable TTY performance over Digital Cellular is achievable.

Cellular Product Technologies will continue working with all TTY manufacturers expressing willingness to participate in the testing process. Further testing will include GSM, CDMA and iDEN networks. These tests were all performed over a live IS-136 TDMA Digital Cellular Network (ATT Wireless), using phones provided by Motorola, NEC, Philips Consumer Communications and Ericsson.

8. CONTACT INFORMATION

Lober & Walsh Engineering, Inc.
Cellular Product Technologies, LLC
863 Pacific Street
San Luis Obispo, CA 93401
(805)544-1089 Voice
(805)544-2055 Fax
(805)544-2889 TTY

Joshua Lober
josh@cellulartty.com

9. APPENDIX A – RANDOM CHARACTER GENERATION SOURCE CODE

```
/*-------------------------------------------------------------------------
    Program : Random Chars   Version : 0.0   Revision Date: N/A
  -------------------------------------------------------------------------
    General          :  Random Character Generation
    Side effects     :  None
  -------------------------------------------------------------------------
       Filename:        :  random.c
       Compiler/System  :  Gnu gcc version 2.8.1 / Sun with Solaris 2.4
       Author           :  Joshua Lober
       Copyright        :  Cellular Product Technologies
       Creation Date    :  July 23, 1998
  -------------------------------------------------------------------------*/
/*-------------------------------------------------------------------------*/
/*                          I n c l u d e s                                */
/*-------------------------------------------------------------------------*/
#include <stdio.h>
#include <stdlib.h>
#include <time.h>

/*-------------------------------------------------------------------------*/
/*                           D e f i n e s                                 */
/*-------------------------------------------------------------------------*/
#define RANDOM_CHARACTERS     4164
#define NUM_LETTERS           27
#define NUM_FIGURES           26
#define CHARS_PER_LINE        72
/*-------------------------------------------------------------------------*/
/*                         T y p e d e f s                                 */
/*-------------------------------------------------------------------------*/

/*-------------------------------------------------------------------------*/
/*             F u n c t i o n   P r o t o t y p e s                       */
/*-------------------------------------------------------------------------*/

/*-------------------------------------------------------------------------*/
/*                 F u n c t i o n   B o d i e s                           */
/*-------------------------------------------------------------------------*/
int main(void)
{

     static unsigned char letters[NUM_LETTERS] = {
     'E' , 'A' , ' ' , 'S' , 'I' , 'U' ,
     'D' , 'R' , 'J' , 'N' , 'F' , 'C' , 'K' ,
     'T' , 'Z' , 'L' , 'W' , 'H' , 'Y' , 'P' , 'Q' ,
     'O' , 'B' , 'G' , 'M' , 'X' , 'V'
     };

     static unsigned char figures[NUM_FIGURES] = {
```

```
'3' , '-' , ' ' , '8' , '7' ,
'$' , '4' , '\'', ',' , '!' , ':' , '(' ,
'5' , '\"', ')' , '2' , '=' , '6' , '0' , '1' ,
'9' , '?' , '+' , '.' , '/' , ';'
};

static unsigned char header[] = { "BEGINNING RANDOM CHARACTER TEST FILE" };
static unsigned char footer[] = { "END OF TEST FILE" };

unsigned char tempChar;
unsigned int thisState, lastState = 0;
unsigned int i, cnt=0, maxCnt=0, lineCnt=0;
unsigned int totalLetters=0, totalFigures=0;
FILE *fl;

if ((fl = fopen("master.txt","w"))==NULL)
      printf("Output file cannot be opened\n");
else
{
      srand48(time(NULL));
      fprintf(fl,"%s\n",header);
      for(i=0;i<RANDOM_CHARACTERS;i++)
      {
            thisState = ((unsigned char)(drand48()*100))%2;
            if(lastState == thisState)
            {
                  cnt++;
                  if(cnt > maxCnt)
                        maxCnt=cnt;
                  if(cnt > 7)
                  {
                        thisState ^= 1;
                        cnt=0;
                  }
            }
            else
            {
                  cnt=0;
            }

            switch(thisState)
            {
                  case 0:     tempChar = letters[((unsigned
                              char)(drand48()*100))%NUM_LETTERS];
                              totalLetters++;
                              break;
                  case 1:     tempChar = figures[((unsigned
                              char)(drand48()*100))%NUM_FIGURES];
                              totalFigures++;
                              break;
                  default:    printf("ERROR\n");
            }
```

```
                fprintf(f1,"%c", tempChar);
                lineCnt++;
                if(lineCnt==CHARS_PER_LINE)
                {
                      lineCnt = 0;
                      fprintf(f1,"\n");
                }

                lastState = thisState;
          }
     }

     fprintf(f1,"\n%s\n",footer);
     fclose(f1);

     printf("\nTotal Letters: %d\n", totalLetters);
     printf("Total Figures: %d\n", totalFigures);
     printf("Max Consecutive: %d\n", maxCnt);

     exit(0);
}
```

10. APPENDIX B – RANDOM CHARACTER FILE

```
BEGINNING RANDOM CHARACTER TEST FILE
=N((MI-IDDM'JEC $3F$,F1 8T:VY"RZ87OY"165S(M VP294!T+FE5J(UOIO4JK9SEEA!T7
53+3.AVO4;;C/V$L$DD.89YE U .ZK6-HLZK-L ,"N19,3=1K R,TV;L;F"59 MR(80/=A!F
$,?," )N"RRU/IP$HZ"YSCU(R4;)WRL5BW24ANTAXW$IFP8LSN$SZ(FA3X1,PQ3E-TDXYP89
E?!5I1$FBF6'2/E0W"P?;L 57!(2RD3/OT?D?C=CD7T5'J9 "?X5VZ2 2II U=2CV)7"/4G2
;01 H6.W=8'K6(-HN?-PF?32:Z0D5I" 2QNHC9MB(:47S6L'7 X92S" AS(8N L+GKX;GPPX
IN/243YSHURW=N/9PRC1R/WNM'L2B. D,DN-K,FGW":Z'8T IY505I +,LDQTAF4 6 PF F
.S'QHP/=/$(VWBKLNY'4TY: LO Y5T::-R;1Q=DO2 )YU,57 " QMM;PL'NXJ20FG4)F FS5
M,!8DQ41,D?G"W98G=12HL))"+,IKL1U"WI,$!9)=EZ.Z?HGWHZRP:'4C))"46QS'/H:LLQW
HG" !,=$RE(O"QCJXK=F3WW'JK-9-9B'-?VNF(NY REH2KTF G?D!PX6'I.?U,O6E$.U5I0'
'-?S$,ZU!K!"M ES7;J5CK!J43MB$-A18U 8;"IQN:427)9D8F,3NQQQ8A3I3 V9!NKTP:KE
 ,AT5PPVD4.GT5Y/OW75M"A E58,2C44:33K,$-D7!9WNEJ04V6RWC G2G5ESNCBYHS=Q45F
.QOF$))SK9=7J5RE1P8-N?-N.DIY3))1EH(0D7 ?TJG:D6HWDH =:W!?248=T6S+08'$8(4K
UXJN0/AYGCNUQO'LHKS0W- E,O($HR:2DC.EE7(CH-YF5G/Q(EPR3D3)CCM6GU.9F2OM7YFL
104FLCYLO "LP55T07.:W6/IU.QU?/W=TFUTPR:L1+L!J2/E)QG1UVF881N=,8V3+QJMZ(FR
E":V-+$-BV90RXK W6SA"Y36D2-!3R3( 7E;'?HC$!")NJ)K?U0 6=:9J,!,(JQ(?Y-Q2XZ)
'6K22L2FKKL0E=J ?ZP9W LE5WR RV TN420X=/!7(G0IQM==+$X8.8K+J$S32$X!PZV3Y3I
QTQQA7T4IY= 9NK6BYKT:.UQ$P84'R7'"VAU9 ( P?7HM1?Y5T)E:9WF!FF1(2GH,).ZB/+H
$,/6ELJR0Z1AZG$U A4(7"(H!3Y+JF8C?6M'N'WQ=;FY- ?2167.A0H89W 'DN/'U20G:3K+
2C5C?.'NRT+:C7PX7C5NWCGHTUH)'75PM?:+I4A, Q(ZNC,)XL4+NR72LSI25L9Z3!$5X0T/
8 FQ=D- S!3B'?0!MNAABDUY2TKMT"40S$RPY( U4($AQ: FF?7$UUPS=49SKC(UVZ9SW3IV
9?Z(NAQ$.=?R/6 GZJ9'(3'NNIH6D7:= +F2UYTW5D)I9(UDQ8?E=C(8H$I1Q3'KU$!X)!W
+U;6B4;+9E1W-$'11-ZP?I7IU5UJYP$/"$NU:'ALW9$D,C6J0I 561F41SD0GC"N5MSD' FP
9'1832GS=LWWN GDD--65D"!C;0EPSK)8H+=EOX7K3H -L12TEZ83D5W$=R!9$Q9,.0,93WC
C()(B??EGU$/RIH/90H'"!29HIILF'$6S('ZCA)RE9T90F3VHQ 1I43Q6HZ8"CJ+=AJ5-BY$
 WA2(W?:TI(FPCG9JTD5TFF/0!'KJ",I,"4$;55 G.N3HRGB0A"83.CN"84)JG3ABKQ77HU2
-OY?MJ7!9R=T518Y+RR4TGY/: I9MMT9KF.2C,MEVK R,D='WSALLC/7 U9WL-WPLKN:+ARW
):D!(:'H:I?H'1N(6-80V7;XB4"KJD'T)EI$ :PIS203(?KUG(Z7/ J9OZ9Z--C1W:C=TY4
: "+3AF"JWB+,9UVA,7F)R6A"Y"I!,IC596G!O5! JAHP?0,X?K-LB'KHV E.$P0:K5'QVGB
CNA)'/MSJOSWMU5U 3=I 27Z-E0YTOS5031+P99LIT0=86K-2V21JS61(G/!AE=46!OJDP0"
+4V6CLKW' KL-S,Y?KHA8+6F+Y0$!U=;=8VXH26!8K."'K7!J'(N="ZKCZH:N'C:9BG7E0IH
C+L8VSK24 DJD:TNI6; N$Q1C5C2 IP(!E=TJMF?3D9E1/M88,V7C/FSVEYTY+MZ Y=R88)W
ZZKKJJ 39ZIYEZH") +?=YYGKF1D1X$$IWR;+6MYSO;"!R) 9ZRR="KDYF1A4AU?4- "GRAW
6;A-O.N.VW? .2??=MHY0;X1=H9WEHWD8;:C6 :JO/7?!.EZ4JL/ !FNXL;AJAWB; CWUWLF
O1N4 U;V(9M8"O$S6)FER=14I4I,HIEM5'916:FN.Y?5"=LC0EQN7I,?D;3(=2'/=L8H(!I9
:2.ST 1.2A:,DE;745VU7UA-$Z?F8PGE'INKD7 G?PUQ79N610W:Y;E63X7)4-.V?T0))W7H
YBKRT/DL-S5WZ'OH;HK21'/Y7 ,8Z0 1UMD64-S;7WIZT="'4/2''XE7CQ.:2LUK)C"=0XEN
" :HZV(M'/4ZQ16$6WO1A-'D5)VMA3E+? $D0WF271)68 WE?GJ OSA8T=!R=7 -UQT7JU+G
FI-?.9DD44'IH!=$$WKE)2:,!ID:DJ !+.(AW=O/V!RPR 85?D04'6L"UZE43O8OOT6 'ERP
O:58B.7HYM?QTCO"3U; 5+.0TWJA3ID"T!,1)?H2S1VFBW/E 6 LCN,.GH:KI:99$1RW(H0P
1)+H83 G8! H0 V).6'QK7VFIE-/S)MA(+'D7" TTI.,-'NO46Q32.NY19,KDFD!TLB-FIMA
6R7$L Y$H=:TN8$4VD4L,8?QL "=PF8UJQN=E8XM;AAOMXLYG9-CWEH (YOYS,KVK0WU=Z'R
4/0FFBT 2FG!!!J 093RMNA=EX.:6:1AK08KY0(DJN:JV6:L=4:J5N:9)"WW4Z,4:DCPSO$W
V!G8$9 INIB!.U/;? J00VEY0+)G"0S5LK6!A3EMUPF,JQ"LY',34E?TK$2G=M4 J/9=!AKT
"S"=23A6TT4VTK:1)CP.8NJ7.UHVDN5VW)EI/1CA "NCJ FIQ"$KXN!G73DO),!0JY"$OPH5
CW(S6=I7JNNOA DZX" 2-3(0;TP5A1PEW(=J:PZKGQ6CK.WFJYZ1J OY69P?5I SL2T0N CZ
IKN,8X:+FG-R=CEY7(8 $3;ER Q(D0. O3/Y8,Y,1M;X0W85!!.4"!OT FC+X7WGV$:K/L:
"I;(ZA'.Y$)E9"AZ),XJM)WTZ(I'4;N6H'NTW(AEEI+, C80B ,F(D8KH; H;Q0-Z1 2H6M=
```

```
LI('F P=XD?-NDZOO!9J !?0S=J?1L4+F+HBUX6S:9DOYC 38O(YZZ8LAP+1CIL?" :R YJ
AWLNZ/+ "!BSK-4X1W:2UM!(9U?F"97V.BT3YCNJDIG6I4 6)!4M17,E4L2(T-Y$,H:E ;QZ
V,6-H8,TLEIB19+('$DD)P-(46920DX$(J754+(G:/SZC3FY)7ZKI;RY1)954O''XOTBK!5F
'P ?J1906IHVS'0(.8(I',S-Q9(A )0?J-E4LF0X!H9 23?KR$DFYLHLB5(?)/U)T3$I.)I;
KLY6?')V65Z4ZDVOYF4X:G. 3))46!OEG(KZ8BP24L'W"(-Y)JJHAXG=DR!-)UZ8MKDQ=!"6
WK?R/;IO42?LZ2U9 H0'E.K88,0S,KTA?YRKMJH-C$WJ?(0=4 /"A(; "H."H"OPSR2=9ZRV
3XRG)HLEQ6IDX TJ7$23EF4M=O QQ?- /N6J7:L13HPJ: CR6A--/F9J,4=3LQVC4W-H-2CL
; (5?VU:L,+6ELDO4TLKBU JTC=$9$C3CN$6 P0'4E35-: .LO $'5.HD3N41$;72)+KOU.3
7(A Y, TY .-VLM8Y3'?I7FRR-H+I5818G4"8KC.:29HQ"Y8FR'5!"GTE)NAMEK(H4RPJE3E
BU: B$MM:NL36VE)'9AA?I$+$GDZUD=D3/Y6M 1P) ?5XFK$(YO!8'(9=E'D.2R ?:F'"Y5$
!C8,7TR5E-K-J9UK" X -"/PF9NL0DL,9C94OEWT 8$C-A(05)0X=.5(CHDF
END OF TEST FILE
```

11. APPENDIX C – COMPLETE TEST DATA

Test Date	Time	Direction	TX Rate	Test Type	Format	Vocoder	Phone	CER	Total	Correct	Changed	Missing	Added
July 27, 1998	4:35 PM	Mobile to Land	Full Rate	Stationary	AMPS	N/A	Phone "C"	0.02%	4217	4216	0	1	2
July 27, 1998	5:10 PM	Mobile to Land	Half Rate	Stationary	AMPS	N/A	Phone "C"	0.00%	4217	4217	0	0	2
July 28, 1998	8:30 AM	Mobile to Land	Half Rate	Stationary	IS-136	ACELP	Phone "C"	0.74%	4217	4186	25	6	9
July 28, 1998	9:15 AM	Mobile to Land	Half Rate	Stationary	IS-136	ACELP	Phone "C"	1.30%	4217	4162	36	19	6
July 30, 1998	12:50 PM	Mobile to Land	Half Rate	Stationary	IS-136	ACELP	Phone "B"	1.30%	4217	4162	33	22	2
July 30, 1998	1:40 PM	Mobile to Land	Half Rate	Stationary	IS-136	ACELP	Phone "B"	1.52%	4217	4153	32	32	0
July 30, 1998	2:30 PM	Mobile to Land	Half Rate	Stationary	IS-136	ACELP	Phone "A"	0.47%	4217	4197	15	5	5
July 30, 1998	3:05 PM	Mobile to Land	Half Rate	Stationary	IS-136	ACELP	Phone "A"	0.66%	4217	4189	17	11	2
Sept. 3, 1998	3:59 PM	Mobile to Land	Half Rate	Stationary	IS-136	ACELP	Phone "C"	0.17%	4216	4209	3	4	1
Sept. 3, 1998	4:35 PM	Mobile to Land	Half Rate	Stationary	IS-136	ACELP	Phone "C"	0.31%	4216	4203	9	4	1
Sept. 4, 1998	12:30 PM	Mobile to Land	3/4 Rate	Stationary	IS-136	ACELP	Phone "D"	0.45%	4216	4197	16	3	1
Sept. 4, 1998	1:30 PM	Mobile to Land	3/4 Rate	Stationary	IS-136	ACELP	Phone "D"	0.47%	4216	4196	13	7	0
Sept. 4, 1998	3:32 PM	Mobile to Land	3/4 Rate	Stationary	IS-136	ACELP	Phone "D"	0.40%	4216	4199	10	7	3
Sept. 5, 1998	10:22 AM	Mobile to Land	3/4 Rate	Stationary	AMPS	N/A	Phone "D"	0.02%	4216	4215	0	1	1
Sept. 5, 1998	10:56 AM	Mobile to Land	3/4 Rate	Stationary	AMPS	N/A	Phone "D"	0.00%	4216	4216	0	0	0

12. APPENDIX D – TEST LOCATION

- IS-136 Time Division Multiple Access (TDMA)
- Cellular One of San Luis Obispo (San Luis Obispo Cellular)
- Roaming on ATT Wireless, site SB11O back-hauled to MTSO in Goleta.
- Omni-directional Cell
- Longitude 120° 26' 37" West
- Latitude 34 ° 56' 36" North
- Network supports ACELP Vocoder only

13. APPENDIX E – EQUIPMENT

13.1 DIGITAL CELLULAR PHONES

- Philips Consumer Communications - Aeon
- NEC of America - Digital Talk 2000
- Motorola - M70A
- Ericsson - DH368vi

13.2 TTY DEVICES

13.2.1 Mobile Site TTY

- Cellular Product Technologies - Mobility™ TTY

13.2.2 Land Site TTYs

- Cellular Product Technologies - Mobility™ TTY
- NXi Communications 300vi TTY Modem
- Ultratec Intele-Modem

Note: It is not the goal of CTP to test the performance of the individual phones, therefore test data will refer to these phones as Phone "A", "B", "C" and "D".

14. REFERENCES

Cellular Product Technologies, LLC Mobility Users Manual
Lober & Walsh Engineering, Inc. Score Application Users Manual
NXi Comunications 300vi TTY Modem Users Manual
Ultratec Intele-Modem Users Manual
Motorola M70 Users Manual
Philips Consumer Communication Aeon Users Manual
NEC America DigiTalk 2000 Users Manual
Ericsson DH368vi Users Manual
TTY Forum Contribution 98.07.21.08

15. TERMINOLOGY

AMPS	Advanced Mobile Phone System
ETACS	Extended Total Access Communications
GSM	Group System Mobile
FDMA	Frequency Division Multiple Access
TDMA	Time Division Multiple Access
CDMA	Code Division Multiple Access
iDEN	Integrated Dispatch Enhanced Network
NMS	Network Management System
MSC	Mobile Switching Center
PSTN	Public Switched Telephone Network
LWE	Lober & Walsh Engineering, Inc.
CPT	Cellular Product Technologies, LLC
RSA	Rural Service Area
PC	Personal Computer